green glow, on disconnecting the induction coil and magnetising the electrodes, a flash of white light was observed within the tube, and irregular green splashes momentarily made their appearance upon the glass.

In conclusion, I desire to offer my thanks to Dr. Silvanus P. Thompson, F.R.S., for kindly permitting me to use the Tesla apparatus at his laboratory, and for the interest he has taken in the progress of these experiments.

"Observations on the Anatomy, Physiology, and Degenerations of the Nervous System of the Bird." By R. Boyce and W. B. Warrington. Communicated by Professor Sherrington, F.R.S. Received December 7,—Read December 15, 1898.

(Abstract.)

In this research the modern methods of investigating the course of tracts and their degeneration in the central nervous system have been used. The previous literature of the subject is scanty. Bumm first gave an account of the various tracts in the brain, and the histological side has been and is still being worked out by Brandis.

Valuable information is given by Edinger in his 'Vorlesungen,' and quite recently the Marchi method has been used and the results obtained described by Wiener and Münzer, Wallenberg and Friedländer.

The anatomy has been studied by sections made in the three planes and stained by the Weigert and Nissl methods, and by observing the course of the degenerated fibres following various lesions, staining by Marchi's fluid.

In the brain of the Bird the cortex of higher animals is represented by a thin pallial sheet of grey matter, forming the mesial and dorsal boundary of the narrow ventricle, and gradually losing itself on the lateral aspect of the hemisphere. Its substance is composed of oval, rather large cells, grouped into clusters, and it contains the fibres of an important tract, called by Edinger the Tr. septomesencephalicus, and by us alluded to as the pallial tract. The hemispheres themselves correspond to basal ganglia; posteriorly they expand laterally into the large occipital lobes. Their substance contains cells resembling those found in the pallium, and which cannot be differentiated distinctly into definite regions.

The hemispheres are connected with the thalamus by a constriction of their substance, forming an isthmus on either side, from which the thalamus in transverse section is seen suspended as a triangular shaped body.

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The other prominent features are the large optic lobes, on the surface of which shining white fibres can be seen, and also the excessive size of the optic tracts, the diameter of which is equal to that of the spinal cord in the dorsal region.

The general plan of the tracts of the central nervous system is as follows :—

I. From the hemispheres tracts arise which undergo a descending degeneration, and terminate in the thalamic and mesencephalic region. There is no direct connection of the cerebral hemispheres with the spinal cord.

II. A well marked tract arises in the mesencephalon, undergoes an ascending degeneration, and can be found to terminate in the substance of the hemisphere.

III. The mesencephalon is the site of a complex system of fibres, which can be grouped as follows :—

(α) The ascending tract to the hemispheres alluded to above (Tr. mesencephalicus striatus).

(β) Arciform fibres decussating in the middle line and reaching downwards into the spinal cord (Forel's and Meynert's fountain decussation).

(γ) The optic tracts and various commissural fibres connected with this.

(δ) A tract originally described by Perlia, and called by him the median optic bundle.

This tract can be well seen after all lesions involving the optic lobes as a well defined degenerate bundle, situated on the inner side of the dorsal aspect of the optic tract, and ending in the ganglion isthmi, which is situated in the optic lobe at the junction of that body with the cerebellum and pons. Peripherally, Wallenberg found that it could be traced to the ganglion layer of the retina of the opposite eye, and Perlia, in his original description, observed the tract as a degenerated bundle found after enucleation of an eye.

IV. The commissural system, including—

(α) The anterior commissure.

(β) The posterior commissure.

(γ) The commissure of the roof of the aqueduct (lamina commissuralis mesencephali) which contains the large cells thought to be the mesencephalic nucleus of the trigeminus.

(δ) The small pallial commissure. Hippocampal commissure of Elliot Smith; commissura anterior et posterior pallii of Edinger.

V. The tracts of the spinal cord, which have broadly the usual ascending and descending course.

Without entering into detail, some points in connection with the tracts of the cerebral hemisphere should be mentioned.

(i) The Tr. septomesencephalicus forms a prominent feature on the mesial wall of the hemisphere, where it is seen as a fan-shaped expansion of white fibres. It rapidly converges to a well defined bundle, which turns laterally, and is seen on the ventral aspect of the brain as a band of fibres situated between the optic lobes and hemispheres. Sections show that the anterior lobe of the brain contributes to its formation, and that it terminates in the epithalamic region. Whilst the main mass of its fibres pass in front of the anterior commissure, a distinct band passes posteriorly to that commissure to end in the region of the ganglion habendulae. This part represents the fornix. It also gives origin to fibres of the "pallial" commissure, and is in connection with the optic tract by a well defined bundle.

(ii) The middle region of the hemisphere especially, but also the remaining parts to a less extent, give origin to the tracts which terminate in the thalamus and mesencephalon respectively, viz., the Tr. striothalamicus and Tr. striomesencephalicus.

(iii) The expanded posterior part of the hemisphere is the site and origin of three large tracts, viz., the anterior commissure, the Tr. occipitomesencephalicus, and a great associational bundle binding the anterior and posterior parts of the brain together, and called the fronto-occipital tract.

In considering the physiological significance of these tracts, their anatomical distribution indicates the paramount importance of the sense of sight in the bird.

The optic tracts and lobes are enormously developed, and the latter have connections with all parts of the central nervous system, being thus a reflex centre of the highest importance. The well-developed posterior parts of the hemisphere, with their connections with the mesencephalon, illustrate in this animal the first formation of a higher cerebral visual centre.

Further, not only is there marked deficiency of sight in the opposite eye after injury to one optic vesicle, but the same symptom is noticed after injury to any part of the cerebral hemisphere. The defect of sight is most marked after removal of the whole hemisphere, or of the occipital portion; but we are of opinion that distinct amblyopia follows a superficial lesion chiefly involving the pallial tract, or after removal of the fore part of the brain, which, as mentioned above, is connected with both this tract and with the occipital lobe.

Two excitable areas are found on the surface of the hemisphere:

One situated on fibres of the pallial tract, near the median plane, and stimulation of which gives, as was long ago described by Ferrier, constant contraction of the pupil of the opposite eye.

By what path such stimulation affects the motor nuclei we do not know, but lesions of this region give rise to a limited degeneration in the pallial tract.

A second situated on the lateral aspect of the surface of the brain, at a point corresponding to the junction of the great striate and occipital tracts.

Stimulation of this area gives rise to complicated movements, which consist chiefly of deglutition, often accompanied by actual pecking and by a rotation of head and neck.

No other motor symptoms were noticed on carefully stimulating the surface of the brain. Nor is any motor defect observed after removal of one hemisphere. After removal of both hemispheres, a condition follows which has been carefully studied by Schrader, and with the description of this author we fully agree. The symptoms vary according to the time which has elapsed since the operation. In the early stage the animal is markedly inert, stands with flexed head, ruffled feathers, and eyes shut; the lack of initiative is pronounced. In the later stage it constantly walks about, and is in a condition of continual unrest, yet always avoids obstacles, and can maintain its equilibrium in various positions.

The relative importance of the mesencephalic spinal system of fibres led us to examine the animals after injury of the optic vesicles for indications of motor defect.

Contrary to what has been noticed in higher animals, we are of opinion that whilst a slight lesion is not followed by any observable motor defect, more pronounced injury gives rise to a weakness on the opposite side, so that the animal falls to that side. If the lesion be very severe, the animal is quite unable to stand, and lies continually on its back.

"On the Reciprocal Innervation of Antagonistic Muscles. Fifth Note." By C. S. Sherrington, M.A., M.D., F.R.S. Received November 29,—Read December 15, 1898.

In a previous communication upon this subject, I gave* the results obtained in an experimental examination of the antagonistic correlation which at least potentially exists in the muscular action of the opening of the palpebral aperture. The *orbicularis palpebrarum* and the *levator palpebræ superioris* are to a certain extent an antagonistic couple. During the course of last year I took opportunity to examine the co-ordination of the same antagonistic muscles in the movement, not of

* 'Journal of Physiology,' vol. 17, p. 27, 1894.